MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2017 Endeavour Round successful proposals

Smart Ideas

Organisation	Title	Duration (years)	Contract value (excl GST)	Public statement*
AgResearch Limited	AI on hooves: Multiplying elite sheep genetics by germline complementation	3	$1,000,000	Artificial insemination (AI) enables fast genetic improvement but it is too costly and sparingly used in the New Zealand sheep industry. Instead, sheep breeding relies mainly on natural mating, which limits the individual genetic impact of each ram. This programme will combine the advantages of AI and natural mating in a new 'natural AI' breeding scheme. By developing 'absolute transmitters', a new class of rams with a proven elite germline, we will short-cut years of conventional breeding efforts. Absolute transmitters are based on an innovative mix of genome editing with advanced reproductive technologies. First, we edit a key developmental gene to disable sperm production in host rams without integrating foreign DNA. Next, the missing germline will be rescued by transplanting germline-competent embryonic cells from an elite donor ram. Absolute transmitter teams are then naturally mated to maximise their genetic impact. Following scientific proof-of-concept, we will target 'short-tail easy-care' sheep, a commercially desirable trait combination which benefits both animal welfare and on-farm profitability. An easy-care donor germline will be multiplied in long-tail host rams. Following mating, the desirable trait will be visible in all progeny. This novel 'AI on hooves' approach provides a superior alternative to AI and delivers a scalable platform technology for rapidly disseminating diverse beneficial traits into extensively farmed livestock. It can be flexibly tailored to different breeding objectives, environmental conditions and market demands, required to secure animal-based food production.
	Harnessing ruminant milk proteolytic	3	$900,000	Appropriate digestion of milk protein is necessary for development of the digestive and immune system, but a new-born human infant cannot achieve this on its own. Instead, human milk

	capacity to improve the nutritional quality and immune protective function of infant formula			contains proteases which "self-digest" milk proteins in the mammary gland prior to ingestion by the infant, releasing peptides critical for growth and development. Ruminant milks also contain proteases, but current knowledge of these is limited, and they are destroyed during processing. Consequently, infant formulae manufactured from ruminant milks often include commercial enzymes. These generate peptides but different in composition to those resulting from the proteases in human milk. Understanding proteases normally present in ruminant milk, and retaining their "natural" activity during processing, will enable significant improvements in nutritional quality and immune protective function of infant formula, by making formula closer to mothers' milk in peptide composition, digestibility and function. This represents a significant opportunity to support the continued development of NZ-made infant formula for high volume, high growth markets in Asia, sustaining NZ's export growth by an estimated $60M p.a. by 2026. Our hypothesis is that proteases naturally present in ruminant milks aid protein digestion, producing peptides (similar to those in human milk) which are vital for growth, development and immune protection of infants. Our NZ-best science team will work with world-leaders from the University of California Davis to address this hypothesis by: 1) establishing protease abundance and activity in ruminant milks; 2) using these enzymes to improve functional characteristics of infant formula, and 3) testing prototype formula in appropriate model systems. Engagement with Māori agri-businesses and involvement of Māori researchers will ensure the project best addresses Vision Mātauranga, thereby also delivering economic and cultural benefits for Māori.
	Transforming irrigation by surface-water assessment using acoustic	3	$1,000,000	Irrigation provides significant economic benefit to New Zealand and to farmers. However, when irrigation transports pollutants (nitrogen, phosphorus, sediment, faecal bacteria and other microorganisms) to water bodies it degrades water quality and so causes significant environmental harm. A smart technology to improve irrigation by avoiding the transport of pollutants would be transformative for both the industry and the environment.

	detection and self-learning control logic			Most of the transport of pollutants occurs when free water is generated on the soil surface. Free water is not bound to the soil surfaces but is instead free to flow directly into water bodies, carrying with it pollutants. The conditions on the soil surface that lead to free water vary strongly and unpredictably in space and time and current smart irrigation technology cannot respond to this variation. "Surface-Water Assessment and Mitigation for Irrigation" (SWAMI) will use the reflection of sound waves as a device to sense the presence of free water. Depending on the condition of the soil surface, the reflected sound will have altered properties (e.g. amplitude and phase) compared to that emitted. That alteration is the basis of the assessment of the free water on the soil surface. The sensor technology will first be tested under ideal conditions before progressing to usage during irrigation events on commercial farms. We will also develop an adaptive control logic that will pair with the sensors to provide the real-time decisions essential to control the irrigation system during an irrigation event. We anticipate significant IP (patents) and the opportunity for industry transformation. Smart irrigation can preserve the opportunity for agricultural production and economic development by minimising off-farm environmental impacts, providing long-term benefits to rural and urban communities. For additional information contact: info@agresearch.co.nz.
	Map and Zap: automated and high throughput mapping and environment friendly, laser-treatment control of weeds	3	$999,999	Weeds cost New Zealand >1.7b per annum and tools for their early control are urgently needed. This project will deliver a novel, chemical-free means for weed management in primary production, public lands and amenity areas. The idea of using cutting edge technology for this purpose is supported by small scale preliminary studies, however, it still needs proof to be considered for development as a weed management technology. The purpose of this research is to inform future action on targeted and efficient weed control and biosecurity practice. Its implications go beyond the group that will participate in the research and will be applicable to biodiversity, biosecurity, amenity land use, sustainable farming and healthy water resources. The research team is made up of a multidisciplinary group of expertise covering imaging, laser, forage, weed, and phenomics, which will directly contribute to the achievement of the

				measurable and realistic objectives within the set milestones and strategy for the project. The benefits of this research include the introduction of a fast and accurate agri-technology to replace or augment a slow and expensive (mechanical) or otherwise inaccurate and unsustainable (systemic application of toxic chemicals) practice of weed control, enhancing profitability of New Zealand's pastoral sector by early weed detection and control as well as innovative and practical solution for land management and biosecurity practice by agencies such as local councils and the Department of Conservation. The beneficiaries of this research will be the aforementioned government departments as well as Ministry of Primary Industries (early detection and fast control of weeds for conservation and biosecurity), farmers (easier access to and identification of weeds- specifically in hill country), and New Zealand waterways (less chemical use by targeted control).
Institute of Geological & Nuclear Sciences Limited - Trading as GNS Science	Tracing Hot Spots and Hot Moments of Nitrate Contaminant Input to Freshwater	3	$1,000,000	Measurements and modelling have enhanced the knowledge needed to address the role of nitrate as a contaminant that causes freshwater impacts, but a major gap must be addressed in our most productive lowland soils. This gap emerges from an inability to resolve dynamic nitrate mobilisation through deep soil and rapidly fluctuating shallow groundwater, where: (1) water age can differ markedly from the age of contaminant nitrate; and (2) nitrate is both produced and removed. Characterising hot spots and hot moments where biological activity intersects with flows of water will identify 'control points' where nitrogen can be better managed to reduce nitrate losses to freshwater. We will develop three 'natural' tracer tools aimed at identifying, classifying and quantifying 'control points' which regulate nitrate production, mobilisation and delivery toward zones of freshwater impacts. Our three new tracer tools include (1) a 'progress bar' for nitrate production and removal processes derived from emerging measurement of isotopes within dissolved nitrous oxide, (2) carbon isotopes to trace biological hot spot inputs, including the 'age' of nitrate, and (3) high resolution water isotope measurements to better identify local delivery of a 'fast water fraction' carrying contaminants into streams and aquifers. By integrating a tracer toolbox of emerging measurement and quantification techniques, we will offer a new vision of where identifiable nitrate sources can be identified and mitigated, creating a win-win by retaining nitrogen as a key nutrient driving production in soil-plant systems, and

				reducing nitrate contamination of water. The toolbox we create will enable self-reinforcing innovation in farm management and regional policy, including with regulators, industry and iwi to mitigate freshwater impacts while achieving more efficient and productive use of agricultural nitrogen.
	Novel inorganic composites for strong near infrared reflecting black coatings	2	$1,000,000	Our association between hot and black is deeply ingrained – unbearably hot black car seats, soft asphalt driveways, and warping black furniture surfaces all remind us of hot summer days. This is all because a black surface absorbs most sunlight and turns it into heat our bodies can keenly sense, particularly on those hot sun-filled days. Innovative technologies have recently been found to create cool white surfaces that reflect most of the heat producing near-infrared radiation. The challenge is, can we make black surfaces that can strongly reflect near infrared radiation, and keep them cool? This project will develop new technologies to create cool black coatings. The objective is to produce novel composite materials that reflect most of the invisible near infrared radiation while preserving the optical impression of blackness. The global cool roof coating market was US$2.80 million in 2015, and its market size is predicted to rapidly increase over the next ten years. Our novel technology will help to meet the high demand for reducing energy consumption for sustainable buildings, and cutting maintenance costs on road surfaces, roofs, and building walls. We aim to develop novel pigment materials for weather, temperature and chemical resistive cool black coatings. Our research will enable a new industry in New Zealand to fabricate these materials, and manufacture and sell these materials to meet the future demand for cool black surfaces. We have gathered a multi-institutional team with strong physics, physical chemistry, and prototype manufacturing expertise, as well as strong industry links. Companies including high-value manufacturers, investors and Māori owned businesses in New Zealand will benefit from this work as being partners in the supply chain.
	Next generation ultra-high frequency acoustic wave filters	2	$1,000,000	Mobile communications are a vital part of life for people. The wireless communication industry is facing rapidly growing challenges, including the increasing number of connected devices and the proliferation of 4G networks and Wi-Fi, which is leading to a rapid increase in the number of Radio-Frequency (RF) bands that smartphones and other mobile devices must support. Currently,

	for 5G networks and beyond			there is no viable analogue solution for an RF filter that can have a variable high frequency of operation. We are proposing a disruptive technology that is compatible with today's microelectronic foundry processes, and will allow more data in a given channel, thus reducing the cost of data transport/acquisition. This project will result in a new class of materials with high coupling coefficient and novel intellectual property that can potentially be commercialised in New Zealand. Our proposed bulk acoustic wave filter material would be a game changer for the communications industry, and New Zealand manufacturers could be the niche provider for this key component in the export market. The general public of New Zealand will benefit by having cheaper personal communication devices that last longer between charges and Wi-Fi access points that consume much less power. Contact: Dr John Kennedy (j.kennedy@gns.cri.nz)
	Flipping the paradigm: feeding methane to cows	3	$999,999	Methane and carbon dioxide are potent greenhouse gases and common by-products from industrial processes. However, when these and other gases are produced, they are generally at concentrations too dilute to be economically useful and are commonly disposed of either by flaring or venting into the atmosphere. This research will develop a biotechnology platform that will take industrial waste gases and convert them into protein-rich biomass to feed dairy, stock and other farmed animals (including in aquaculture). Our process will utilise the unique characteristics of naturally-occurring and non-GM indigenous extremophilic microorganisms. We will demonstrate this biotechnology platform using two industrial examples: geothermal power generation; and oil and gas production. Our process will be nutritionally-flexible, allowing us to tune our biomass product to target the needs of specific biofeedstocks. The process will also be adaptable to a variety of industrial waste gas compositions, such as those from smelters, municipal treatment plants, thermal power plants and landfill, offering more widely the advantage of value-adding and improved environmental performance to what are considered industrial wastes.
Landcare Research New Zealand Ltd	The Lake Snow Toolbox: detecting and quantifying an	3	$1,000,000	'Lake snow' or 'lake snot' is a problematic slime caused by the alga Lindavia intermedia. It is a threat to tourism, municipal water supply, irrigation and hydroelectricity infrastructure, and to the recreational and cultural values of some of NZ's most pristine lakes. This alga has begun

	emerging environmental problem			spreading in the last 10 years, coating fishing lines and clogging water supply units. Like didymo, lake snow threatens our highest-quality freshwater ecosystems. Scientists, councils and other stakeholders agree that eradication of the alga is impossible, but it may be possible to reduce or eliminate its slime production. However, to do this we need a much better understanding of its ecology, requiring new tools to quantify both the alga and the slime it produces. This will enable us to test hypotheses designed to achieve effective management options for lake snow. Working closely with stakeholders, we will combine our skills in algal biology, lake ecology, chemical analysis, electronics and software engineering to develop a 'Lake Snow Toolbox' to determine the causes of lake snow production. We propose to develop a new chemical analysis for lake snow, and to adapt sophisticated optical sensing methods to create low-cost, mass-produced sensors that can specifically detect lake snow 'threads' and exclude other types of particles. The slime's remarkable ability to bind to substrates can be used to quantify its production over large areas, and DNA-based tools can be adapted to quantify the alga itself, as well as its slime-producing activity in samples. Our project will benefit lake users, councils and industry, who are vulnerable to millions of dollars in lake snow management costs annually, and will assist iwi and iwi partners as guardians and developers of NZ's freshwater resources.
	A fruit-fly screening model to accelerate development of species-selective vertebrate toxins	3	$999,999	NZ needs new and better ways of controlling vertebrate pests if we are to reverse the decline in our native species and achieve the national goals of Predator Free 2050 and Zero Invasive Predators. Large-scale predator control requires poisons, because trapping is too costly. However, current poisons (1080 and anticoagulants) are controversial due to risks to non-target species. Therefore, species-selective pest toxins that have minimal non-target effects are urgently needed. Our research will develop new tools to significantly accelerate the development of selective toxins that are active only against particular pest species. We will develop a novel way to rapidly identify high-quality pest-selective toxins. We will use the fruit-fly as a model system for in vivo development by applying an innovative screening

				technology used by pharmaceutical companies to develop human medicines. This will significantly reduce the time and cost of developing toxin products, and reduce animal welfare costs through reducing the number of animals needed for product development. To demonstrate our new toxin development platform, we will use it to identify mouse-selective toxins. Mice are the most economically important rodent pest globally, yet there are no toxins suitable for their large-scale control. Mouse-selective toxins will be prime candidates for use in sensitive areas such as kea sanctuaries, where 1080 by-kill is a potential hazard, or near waterways, where there is potential danger to aquatic life. Once we have demonstrated our proof of concept with a mouse-selective toxin, the new platform will be extended to other pests e.g. stoats. Pest-selective toxins will enable us to reduce the environmental impact of large-scale pest control, and bring other economic and social benefits. In particular, taonga species of importance to Māori will be protected.
Lincoln Agritech Limited	Magnetotactic bacteria for removing contaminants from manufacturing processes	2	$1,000,000	Our new manufacturing biotechnology, adapting naturally occurring magnetotactic bacteria (MTB), has broad application for removing H2S from industrial processes. We will use removal of H2S in the wine industry ($1.6B NZ exports) as an exemplar, replacing the current use of copper for this purpose. Copper is banned from organic wines, has potentially adverse health implications and has led, on occasion, to NZ wines being rejected by the EU. Other markets, e.g. Japan, which is an important growth market for NZ wines, have zero tolerance for copper. Therefore our technology will deliver to NZ Winegrowers's (NZW's) strategy of sustainability, cost reduction, brand protection, maintaining market access and quality wine styles thus contributing to their goal of $2B wine exports by 2020. We will develop a working model for MTB remediation of H2S in wine production, protect IP and use our established relationships with NZW (100% penetration into NZ's wine makers), and wine producer's Māori-owned KonoNZ, and Indevin, to drive uptake. NZW's established communication pathways will publicise the technology's potential to the wine industry. We will prototype the technology and explore export opportunities with electronics companies, e.g. Kamahi Electrics and 4D Electronics. LAL has a history of successfully working with commercialisation specialists to deliver technologies to market, eg. "Aquaflex" soil moisture

				sensor (Streat Instruments), colour-stick technology (ZESPRI), and biosensors for quantifying organic pollutants and lactose (CertusBio). Hydrogen sulphide is a toxic, corrosive, environmental and industrial pollutant and is produced as a by-product of many industrial processes; our MTB technology will also be applicable for removing H2S from anaerobic digesters, pulp and paper processing, tanneries, mining, organic waste in primary production and municipal wastewater treatment systems.
Massey University	Wastewater Treatment 'Advanced Extraction Modules': De-risking to enable end-user uptake	2	$989,594	Name any small town/community in New Zealand, look at what stands between its wastewater and the environment and almost every time you will find a waste stabilisation pond (WSP). Indeed ponds are one of the most common wastewater treatment systems used across the globe. But as increasing levels of environmental protection are demanded, the Achilles heel of these otherwise highly effective systems is failure to fully remove nutrients that cause excessive weed growth in waterways. Furthermore, while algae in the pond are critical to the cleansing process it creates a 'murky' green effluent that is then discharged into our waterways. A common solution involves dosing industrial chemicals into the pond effluent to create small 'lumps' of chemically bound solids that then need settlement, extraction and ongoing trucking to landfills. Another option is to abandon the ponds and build new high tech systems, but this means wasting the hundreds of $millions already invested and raising council rates to fund their construction. With these alternatives our communities lose the advantage that made ponds so widespread to start with – their simplicity. Operators of WSPs, such as local councils, are caught between intense pressure by environmental regulators to upgrade treatment while serving communities that struggle to fund the massive upfront capital expenditure needed for alternative treatment processes. Professor Shilton is an expert in pond treatment and indeed produced what has been called the 'definitive textbook' in the field. He has conceived a novel solution that compacts key removal treatment mechanisms into replaceable modules. These simply connect in at the exit of existing systems to immediately provide markedly improved effluent quality. "Simplicity is the ultimate sophistication." > ? Clare Boothe Luce

	Design and manufacture of controlled release fertiliser system for precision nutrient delivery	3	$999,327	Agriculture has been central to the development of the New Zealand economy and is still a major contributor to employment and export earnings. Agriculture has, however, impacted our environment, through lower water quality, greenhouse gas emissions and ozone depletion. Massey University is well connected to the development of agriculture and is teaming up with CRL Energy to develop a new way to supply plant nutrients that has a significantly lower environmental impact than conventional fertiliser application. This research will deliver new fertilisers with superior controlled release properties and increase the precision of fertiliser application so that the right nutrients can be delivered exactly where they are needed. This increases agricultural productivity and reduces environmental impact from nutrient leaching to waterways and release of greenhouse gases. This will enable the development of new precision agriculture manufacturing and greatly increase the export of fertiliser from New Zealand, improving regional economies and providing well paid and highly skilled job opportunities.
	Electro spun Bio printing Technology in the Production of Complex Collagen Tissues	3	$998,532	This project will develop a novel 3D printing methodology that is capable of printing aligned electrospun nanofibres. Complex shapes can then be printed by using precision application mechanisms used in 3D printing technology. We aim to develop novel technology to overcome current limitations in 3D printing and generate highly ordered collagen nanofibre-based structures. Our team has selected the cornea as a challenging example of how this new technology can impact our everyday lives. Corneal disease is a leading cause of blindness, second only to cataracts, and typically requires cornea transplantation treatment. Internationally, there are 10,000,000 sufferers of corneal blindness compared to the 100,000 transplants performed each year. With such a shortage of donor corneas, our goal is to develop the 3D technology to the point where suitable corneal tissue can be printed to order and shipped worldwide. The successful completion of this research, using corneal implants as an exemplar, will overcome the great difficulties associated with Nanoscale and long-chain nanofiber 3D printing without depending on extreme heat or pressure. New Zealand's cattle and fish Industries ensure that there is an abundant supply of material to

				produce collagen, also creating a pathway for the development of a high-value biomanufacturing industry in New Zealand. This new 3D printer nanoscale fibre technology will result in the capability for the generation of many products in the ever-growing medical transplant industry. The ability to utilise 3D printing to replicate complex highly ordered nanofibre-based structures will yield benefits to both local and international industry, not only in medical technology, but also in the industrial filtration, fibre-reinforcement, electronics, biotechnology and manufacturing sectors.
MetOcean Solutions Limited	Machine learning for convective weather analysis and forecasting	2	$500,000	Imagine a smartphone app which warns you that severe weather is expected within an hour where you are. Perhaps warning you of heavy rainfall, dangerous winds at your workplace, or alerting you to take in the washing. This project aims to use the massive amount of high-resolution earth-sensing data now available to generate hyper-local precise weather forecasts. > > Weather greatly influences all aspects of our life. Our largest industries are weather-dependent, including forestry, agriculture, fisheries, tourism, building, shipping and freight. Kiwis and tourists alike enjoy activities such as camping, tramping and fishing, all of which are weather-sensitive. > > New Zealand is often affected by convective weather - which produces thunderstorms, squalls, hail, heavy rainfall and tornadoes. These significantly impact the safety, efficiency and well-being of our industries and the general population: recent severe weather cost millions, and several lives have been lost. > > Traditional weather forecasting relies on experienced human forecasters tracking convective systems on satellite imagery, making predictions about where and when they will strike next. Such forecasting is resource-intensive and of limited accuracy. > > This project unites three innovative organisations: MetOcean Solutions, Auckland University of Technology and the MetService. We propose using the novel technique of machine learning to improve weather forecasts, using cost-effective and reliable computer power to advance weather forecasting beyond what can be achieved by humans alone. > > The technology for such research is available, including satellite imagery from the Himawari satellite and machine learning approaches invented by the Auckland University of Technology. However, the application of machine learning to satellite imagery for forecasting hyper-local convective weather will be a world-first. We propose that NZ be part of developing it, and the first to reap the benefits.

National Institute of Water and Atmospheric Research Ltd	Trace metal limitation of phytoplankton growth in New Zealand lakes	3	$849,999	Clean water is of utmost importance for primary industries, the tourist sector and for human consumption, so there is growing concern about blooms of cyanobacteria that produce toxic compounds and degrade water quality. Controlling blooms in lakes is challenging, but to achieve this the government requires that regional councils set nutrient limits to reduce lake eutrophication. Currently, nitrogen load reduction is planned or underway to limit phytoplankton growth in lakes in the Taupo Volcanic Zone (TVZ), which covers the central North Island. However, reduction of nitrogen loads may, in fact, favour cyanobacteria that can obtain nitrogen from air. All organisms need trace metals (TMs) to grow, particularly cyanobacteria which require them to access dissolved nitrogen gas in water. TMs such as cobalt are so low in TVZ soils that livestock were often sick due to these deficiencies, and TMs are now routinely added to fertilisers to alleviate these deficiencies. Our preliminary studies suggest that TMs are low in the waters of TVZ lakes as well. Thus, TM scarcity may help maintain water quality by limiting the growth of phytoplankton. We will investigate TM concentrations in the TVZ lakes to determine whether their concentrations limit both nitrogen fixation by cyanobacteria and phytoplankton growth. If so, this may indirectly assist the success of the nitrogen load reduction strategy. The research will assist regional councils and landowners in meeting nutrient limits by providing methods to set effective nutrient load limits in regional plans. The primary end-users will be the regional councils, farmers, and iwi in the region. This research will provide an improved understanding of the value of nitrogen load reduction in the regional plans. For more information contact piet.verburg@niwa.co.nz.
New Zealand Forest Research Institute Ltd Trading as Scion	Small molecular change in cell walls for big impacts in pulp processing	3	$998,574	New Zealand's forest industry faces strong international competitors. The adoption of GE (Genetic Engineering) by overseas forest owners has given them a competitive edge over New Zealand in terms of productivity. New Zealand forest owners are interested in deploying only sterile GE trees in order to mitigate social and environmental concerns. These sterile trees, will be used as platforms to implement useful traits. Scion is anticipating this transition and is supporting the forest owners by generating

				useful traits for industry. This research, in partnership with the University of Cambridge (UK) and the Universidade Estadual de Campinas (Brazil), will lay the foundation for elucidating the molecular structure of softwood secondary cell walls. This blueprint, focusing on Pinus radiata, (the most dominant species cultivated in New Zealand), will be the basis needed for future work. Here, we aim to generate a pine variant with one enzyme deficiency. This will lead to a cultivar with high processibility for the biofuel and pulp industries. Moreover, during the pulping process this new pine will reduce the production of hazardous wastes (halogenated organics). The benefits of the introduction of this cultivar will be: • A more environmentally friendly pulping industry (less energy input, reduction of chemical use and toxic wastes). • Increased competitiveness of the New Zealand forestry industry (higher resilience, faster turn-over, more flexibility, faster adaptation) Deploying GE trees would be a significant step towards facing the industry's challenges. Using GE to develop trees with shorter rotation times, greater wood volume, and improved quality is predicted to add $6.5B to New Zealand's GDP by 2051, while the limited reproductive ability of the trees would provide unique benefits such as prevention of wildings and pollen dispersal.
	Sequestering natural and anthropomorphic trace metals from water	2	$978,523	Heavy metal contamination (e.g. arsenic, cadmium) in drinking water is irreversibly affecting the health of millions of people worldwide. Such contamination has also been found in NZ waters due to geothermal activity, fertilisers, solder and piping, and pesticides. > In NZ, the 2017 Annual Report on Drinking Water Quality reported that 10,000 people were consuming arsenic concentrations up to twice the recommended value by the World Health Organisation. Excess levels of arsenic have been reported every year since 2000. Whilst methods to remove heavy metal contaminants exist, they typically rely on large, complex, and expensive infrastructures. Our technology will create affordable and customisable filtration systems that will specifically extract arsenic, copper and cadmium from water solutions but will also be transferrable to the recovery of other metals such as gold and rare earth metals. > The technology benefits include generating new export revenue and providing healthier water. The project delivery and

				completion will be enabled by the unique combination of expert skills from Scion and Universities of Canterbury and Surrey, and innovative NZ start-up company Ligar. > The project aligns with the Business Growth Agenda and the National Statement of Science Investment, and contributes to the government's environmental and health objectives. It also aligns with activity in the National Science Challenges. The project will strongly adhere to the Vision Mātauranga principles of Taiao (environment) and Hauora (health) to improve water quality both nationally and globally. This project is endorsed by the Te Arawa Lakes Trust, aligning to their strategies to improve the health of the local lakes region, as well as engage with the younger community to transfer valuable knowledge and sustainability principles.
The Research Trust of Victoria University of Wellington	Reconstructing real world lights and reflectance models for Augmented and Mixed Reality	3	$999,999	The visual effects and augmented/mixed reality (AR/MR) industries require realistic representations of the real-world. Seamless blending between virtual objects and background real-world scenes is important if people are to feel that both the virtual objects and real-world footage are part of the same world. Accurately modelling real-world properties of light and reflectance is extremely difficult. Current techniques require specialised devices and manual refinements by highly skilled artists, and the result is far from satisfactory. Although a technique called inverse rendering can automatically estimate light and reflectance from a photograph, it has significant limitations. To address this 'inverse rendering' problem, we propose a novel method of producing real-world lighting using what's called image-space analysis. Combined with 3D geometry capture and reconstruction, our results of estimated real-world light will provide a complete solution for appearance modelling for inverse rendering. Our results of estimated real-world light and reflectance will provide far more realistic visual output in AR/MR than any previous technique has achieved. Our research has many significant potential applications. Our methods will allow the convincing incorporation of virtual objects into the real-world footage, they will stimulate a new market for virtual reality and augmented reality, and they will provide a novel platform for simulating mixed reality environments in digital manufacturing and virtual prototyping for use in industrial and architectural design, education and medical simulations.

University of Auckland	Mapping the genomic novelty and functional capacity of a typical groundwater ecosystem	3	$995,229	Aquifers are a source of fresh drinking water, they feed our streams and lakes, and are home to diverse and unique organisms. Despite the importance of aquifers, the quality of the nation's groundwater is lowered by excessive nutrients derived largely from agriculture, which is intensifying. Recent surveys of nationwide groundwater quality found nitrate concentrations were above those considered safe for drinking or ecosystem health in around 2-5% and 9-13% of aquifers, respectively. The majority of monitoring sites (62-73%) also have nitrate values exceeding those recommended for the protection of ecosystems, although the threshold used for this depends upon values defined for surface water ecosystems, as none exist for groundwater. Microorganisms are largely responsible for driving chemical reactions in aqueous environments through a wide range of enzymatic reactions. However, there is a scarcity of information on their natural character and function in aquifers, including how they transform nutrient pollutants. Our proposed research will use whole system genome and gene expression recovery and integration methods to capture the diversity of microbial processes and nitrogen transformation pathways occurring along an agriculturally influenced groundwater nutrient gradient. Using these methods we will link biological reactions leading to environmentally positive outcomes (nitrogen removal as N2 gas) or deleterious outcomes (nitrogen retention; generation of nitrous oxide – a greenhouse gas) to nutrient inputs, and determine the latent genetic capabilities of groundwater communities. By gaining an understanding of the natural microbial character of groundwater and mechanisms that promote beneficial groundwater-nutrient conditions, we will be able to better improve management of groundwater quality, and criteria for setting nutrient limits. Our goal is to promote a better understanding of aquifer biology, and ultimately higher quality groundwater for the nation.
	Novel potent DNA alkylating agents as warheads for arming	2	$1,000,000	Antibody-drug conjugates (ADCs) are a new type of cancer treatment. It has been known for a long time that certain antibodies can recognise markers on the surface of tumour cells and so selectively localise in a patient's tumour. Sometimes this binding can have useful antitumour effects in its own right, but in other cases antibody binding generates little tumour response. In

	antitumour antibodies			an ADC a drug that is able to kill tumour cells is chemically connected to the antibody. After the ADC binds its target it is taken up into the cell and the drug is released, thus directing the toxic effects selectively to the tumour. Two such ADCs have been approved in the last 6 years as new antitumour agents and more than 60 different ADCs are currently being tested in patients around the world. Particularly active ADCs can be made using drugs that are toxic to tumour cells because of the unusual way they bind to DNA. We are experts in the design and synthesis of these types of drugs and have identified new examples that we expect will produce especially effective ADCs. We will try out various ways to make these compounds in the laboratory, then measure their properties to test our predictions. We will also make analogues containing a chemical handle to demonstrate that linking to an antibody can be easily achieved. Together this information will form the basis for several patents that will be filed, supported, and commercialised by NZ-based investors. For further information contact Dr Moana Tercel , m.tercel@auckland.ac.nz.
	Speleothem Records of New Zealand's Earthquake History	2	$999,822	A record of past large earthquakes is essential for forecasting and preparing for future earthquakes in NZ. However, the short period of human inhabitation of NZ and imperfect preservation of paleo-earthquake evidence in NZ's dynamic landscape mean that our earthquake record is incomplete and restricted to the recent past. We will develop a new tool for detecting and dating past earthquakes further back in time and to places where the likelihood of large earthquakes remain largely unknown. This tool is based on investigations of cave deposits (i.e., speleothems — stalagmites and stalagtites) found throughout NZ. These deposits should record large earthquakes by: (1) strong shaking either causing speleothems to break, fall to the cave floor and cease growth, or alternatively preserve irregularities in their columnar growth structure; (2) disruption of the cave's hydrological system and water flow/chemistry. Dating of broken tips or irregularly grown speleothems and chemical changes in them may be able to greatly refine and extend NZ paleo-earthquake records. We will develop and verify this tool by documenting the effects of the 2016

				Kaikoura earthquake on nearby caves. We will then search for similar "damage" in other cave sites throughout NZ that can be compared with conventional, older, past earthquake records at those sites. If successful, this tool will extend the past earthquake history of faults, refine the mega-earthquake and tsunami history on NZ's plate tectonic boundary, and reveal if and how often large earthquakes occur in the upper North Island. Such information will provide improved constraints on hazards, risks, and potential losses associated with earthquakes, which can guide asset and insurance managers, engineers, and national agencies striving to reduce risks and costs due to major earthquakes.
	Portable and handheld device for diagnosis and differentiation of skin cancers	3	$999,804	Skin cancer is a very significant health challenge worldwide and is particularly devastating in New Zealand. New Zealand has the world's highest incidence of skin cancer, four times that found in the UK, US or Canada. The loss of life and economic impact through healthcare expenses and lost productivity costs New Zealand $150m per year. One New Zealander dies from skin cancer every day, and 5-year survival rates drop from 98% for localized (early) melanoma to 16% for metastatic (advanced) disease. These numbers highlight the importance of early, reliable diagnosis and staging of suspicious skin lesions. This is especially important for Māori and Pacific peoples, among whom skin cancer rates are 4x higher than they are for NZ Europeans. Unfortunately, our current diagnostic methods simply are not reliable enough. This Smart Idea meets this urgent need for a better way to diagnose and stage suspicious lesions. Our team of expert scientists and doctors will work together in the Photon Factory at the University of Auckland and in clinics like Middlemore's"See-and-Treat" to develop, optimise and validate a new handheld device based upon advanced photonics and sophisticated data analysis. Healthcare workers will use the device at point-of-care in clinics, hospitals or in remote areas to non-invasively, rapidly and accurately diagnose skin cancers with better accuracy. This new device will alleviate human suffering from skin cancer in New Zealand and around the world. It will also generate revenues and economic benefit to New Zealand through device manufacture, sale and export. Hence this Smart Idea addresses both human health issues and national science investment strategies to grow and diversify the NZ economy through

				entrepreneurship and high-value technology. For more information please contact c.simpson@auckland.ac.nz
	Selective capture, selective release: pulling intact cells from complex mixtures	3	$869,316	There is a large global market for molecular (DNA/RNA) diagnostics. All such methods need clean cell samples. Since the majority of cancer deaths are due to metastatic disease with early detection being critical to minimise the risk of malignant spread. Global efforts have thus focussed on the selective extraction of potentially metastatic cells from fluids such as blood and urine, followed by nucleic acid profiling for diagnosis and insight into the disease progression and treatment. Still, the most significant challenge remaining is the capture with high specificity (enrichment) of aberrant cells from the blood and other body fluids: the “needle in a haystack” problem. In this research we propose a new, general and powerful method for the selective capture and release, of intact rare cells from complex media. Specific capture from large volumes and release into a small volume of analysis medium concentrates the target, multiplies the rejection of non-target cells and greatly diminishes interference with the subsequent nucleic acid analysis. The developed methodology will be applicable to viruses and bacteria, and plant and animal pathogens, and will be suitable for the rapid processing for analysis of relatively large volumes of fluid – from blood and urine to drinking water.
	Complete Atrial Fibrillation mapping using non-contact electrodes	2	$1,000,000	Atrial fibrillation affects 1 in 4 adults and treatment of persistant atrial fibrillation is usually difficult. To fix AF it is necessary to identify and interrupt electrical pathways inside the heart muscle with radio frequency ablation. The challenge is to know where to apply the ablation. Presently electrodes are put inside the heart to map the electrical pathways, but it is difficult to hold the electrodes against the heart surface to get the data. This project will use mathematical techniques to derive the electrical pathways on the heart from measurements taken inside the heart chambers without needing direct electrode contact. This will improve accuracy in locating ablation sites, improve procedural success rates, and develop an industry supplying non-contact basket electrode catheters. The research is linked to centres of research excellence in Australia, France and the US.

	Advances in fermentation using underwater sound	3	$999,999	Human use of the process of fermentation has been around for more than 12,000 years and is best known for using yeast for making bread rise and for brewing alcohol. Fermentation is now used in the production of a huge range of consumer and industrial products ranging from complex drug compounds, cleaning agents, food colourants, biofuels and chemical paint ingredients, while also remaining fundamental to the making alcohol. Globally the fermentation industry is valued at US$127 billion a year and rapidly growing. Despite the major importance of fermentation, there appears to have been no previous research into the use of underwater sound to influence the fermentation process. Initial research at the University of Auckland has found that sound can play an important role influencing fermentation efficiency and the nature of the end products. This research will determine how different components of sound, such as pitch, loudness, and fluctuations in these qualities, can beneficially alter fermentation processes. The research will experiment with sound in beer fermentation because it has short cycle times and is a well known process with well understood end points. Researchers from Auckland and Otago Universities will examine the metabolic and genetic responses of beer yeast to different sounds, and determine the changes in the fermentation yield and flavours. The research includes one of the largest and most innovative New Zealand craft brewers, Garage Project. They will contribute their brewing expertise and commercial scale capacity to the project in our quest to deliver a world-beating beer based on novel scientific insights into the effects of sound on fermentation. The results of the research will also have significant potential for wider application in the enormous global fermentation industry.
	Lens protein adhesives for use in ocular surgery	2	$977,236	The surgical use of adhesives opens up the opportunity for minimally invasive procedures and suture-less surgeries. Current adhesives are largely synthetic, and so may have problems with toxicity and lack transparency. We propose to develop a new surgical adhesive – formulated from proteins. The major component of this bio-adhesive is proteins that are native to the eye, and so we are developing this new technology for use in ocular surgeries. Our source material comes from fish eyes, a low value by-product of the New Zealand fisheries industry. We aim to produce a new adhesive with sufficient strength to be used in surgeries, such as the

				repair of corneal perforations. The unique optical properties of the material will allow improved patient vision throughout healing. As the material formulation is non-toxic there will be reduced scar tissue formation, and the adhesive material will be designed to degrade at the same rate as repair.
	Impact for Spray Drying: Optimizing Drop Dynamics with Surface Designs	3	$1,000,000	This project will improve the process for producing milk powder, New Zealand's top export commodity, as well as premium food products such as bulk infant formula. To do so, we will optimise spray drying, a key step for removing water from milk. During spray drying, small droplets fall from the top of a heated conical silo, eventually hitting the sides, and powder is collected at the base. Our primary focus will be on the internal surfaces of spray dryers. The project team has recently studied impacts of liquid drops upon surfaces with specially designed nano- and microscale structure, or roughness. One of the important findings of this work is that specific impact outcomes – sticking or rebounding intact, for example – are favoured for particular surfaces. By controlling the outcomes of drop impacts, spray dryer production could be improved in several ways. Firstly, drops sticking to dryer walls can create biofouling, necessitating cleaning and therefore production downtime. Controlling drop size and adhesion can also reduce the risk of dusk explosion that is inherently present in the production of powders. Finally, the energy efficiency of spray drying is optimized when drops are relatively small, and remain airborne rather than attached to dryer walls. New Zealand has a large installed base of capital spray drying equipment for processing milk and premium foods, and the potential benefits of this project include significant economic boosts for local producers and equipment manufacturers. The project will have wider impact for New Zealand beyond food production, as drop impacts on surfaces are also important for spraying and irrigation in agriculture, application of coatings, and energy and transport infrastructure that is exposed to rain and ice.
University of Canterbury	Discovering petroleum associated	3	$999,999	Understanding what energy resources exist and whether and how to make best decisions around the use of these resources will be crucial for New Zealand in the future. New Zealand has a natural endowment of developed oil and gas fields which account for up to a half of the national

	with buried volcanoes			crude oil use and all of its natural gas consumption. Over the coming decades the important contribution of petroleum to the economy is expected to decline without new discoveries. Key to making decisions about how to meet increasing energy demands in the future will be understanding what energy resources are available and how best to utilise them. Volcanoes deeply buried in New Zealand sedimentary basins have the potential to host large volumes of hydrocarbons, yet they have been under-explored. Our research aims to develop three-dimensional static and dynamic models of sedimentary basins with buried volcanoes, to examine how volcanic systems can affect the migration and potential accumulation of oil and gas. These models will be constructed using subsurface and outcrop information from ancient and modern volcanoes. The models will be entered into numerical flow simulators to determine the geological conditions that promote the formation of petroleum accumulations. The results will be important for government and government agencies, petroleum companies and researchers wishing to assess the resource potential and to develop petroleum exploration strategies. The knowledge generated during this study will provide decision makers and stakeholders with a superior means of identifying energy resources and exploration strategies.
	Low carbon magnesium oxide cement and hydrogen manufactured from olivine basalt	3	$999,999	Portland cement concrete is the most widely used building material on the planet. The annual global production of approximately 20 billion tonnes of concrete results in the yearly consumption of more than 4 billion tonnes of cement. Industries directly associated with cement and concrete production contributed over $1.9 billion to the New Zealand economy in 2006 alone[7]. With the closure of the Wesport cement plant, approximately half of the 1.1 million tonnes of cement currently consumed annually in New Zealand now needs to be imported to supply the local market. Concrete is versatile, durable, and easy to use; however, these advantages are balanced against the environmental and economic cost of producing cement—the essential ingredient in concrete. Today, the manufacturing of cement is responsible for almost 8% of worldwide man-made emissions of carbon dioxide. With global cement production already in excess of 4 billion tonnes/year[8], investigations are underway worldwide to identify ways to mitigate the effects of this highly polluting yet key global industry.

				The research set forth in this proposal examines a paradigm-shifting alternative to the existing cement production process. An alternative cement that utilizes magnesia and naturally occurring or waste silica has the potential to not only lower the material cost but also significantly reduce manufacturing-related energy consumption and the amount of greenhouse gases emitted. Preliminary investigations, with other forms of magnesia, show it is possible to produce a cement with a compressive strength that is suitable for many civil engineering applications. Once the technology is proven locally it may be exported internationally to create a more economical and environmentally sustainable building product.
	Development of a simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings.	3	$1,000,000	This proposal builds on our recent demonstration of peptide fibrils that reversibly form hydrogels, creating “stimuli responsive hydrogel membranes”. Using this technology, we will develop a novel assay platform with broad application due to its simplicity, ease of use, and temperature tolerance. This will allow screening tests to be undertaken in remote and adverse environments by relatively untrained users. There is an urgent need for cheap and effective screening devices that can be used in non-clinical settings. Diabetes is a good example, due to its rapidly expanding population incidence. Glycated haemoglobin is an accepted and universal biomarker for diabetes. We will produce a proof-of-concept assay device for glycated haemoglobin to test our technology. Our simple assay will monitor the passage of blood through a “stimuli responsive hydrogel membrane”, which is dependent on the concentration of glycated haemoglobin. Future development of the platform will seek to develop simple assay test solutions to address water testing issues in remote areas and "pen-side" testing for animal diseases. To inform the engineering and design of the assay platform we first need to understand how the peptide self-assembles into hydrogels and how we can control reversible assembly and disassembly.
	Manufacture of structure-optimised homogenous	3	$1,000,000	Glycoproteins are amongst the world’s most valuable commercial products. In 2015, the combined global market for protein therapeutics was US$174 billion, and is predicted to rise to ~US$250 billion by 2020. A very significant proportion of these proteins are glycoproteins, i.e. proteins with sugars attached, and these sugars are vital for their function/activity.

	glycoprotein therapeutics			The current methods for manufacturing glycoproteins are extremely expensive, time consuming, and invariably produce inseparable mixtures of products, only a fraction of which may display the desired activity. All current glycoproteins are sold as complex mixtures of materials. Our vision is to develop a totally new and novel approach to making glycoproteins. Our objectives are three-fold: (i) To develop a process that will produce pure products. (ii) To precisely select the structure of the carbohydrate component to optimise the product's function. (iii) To significantly reduce the overall manufacturing costs by increasing production efficiency and yields. We will achieve this by developing a new NZ-biotechnology capability, which synergistically builds upon existing NZ strengths in carbohydrate chemistry and molecular biology. Our vision is to create an NZ-based commercial vehicle to develop and commercially exploit this production process, both alone and in partnership with multinational biotechnology companies. The key end-users of the new manufacturing method will be global biotech companies and, through them, users of glycoproteins for whom costs can be decreased and the effectiveness of treatments will be improved – millions of sufferers from a wide variety of maladies worldwide, including many in NZ.
	Building bioinformatic software for controlling protein expression	3	$1,000,000	A number of pharmaceutical and agricultural processes rely upon recombinant protein technology. These processes include the manufacture of the insulin that diabetics depend upon, clotting-factors that haemophiliacs require and the rennet substitutes that cheese-makers need. Yet the design of systems for recombinant protein expression can be extremely complex, difficult and failed designs are a common and expensive problem. The fundamental issue is that an enormous number of potential DNA sequences can encode a single protein, and relatively few DNA sequences will be efficiently translated into protein. We will develop a sollution for dramatically improving the selection of DNA for recombinant protein production. Our bioinformatics research has found a major new factor to why finding just the right DNA sequence is so challenging. This factor is due to the influence of abundant, yet

				frequently overlooked, RNA molecules in the cell. By accounting for these abundant RNAs we can dramatically enhance the selection of DNA for recombinant proteins. We will incorporate our finding into what will become a new software platform. This software will be of benefit to the global biotechnology research and development market, with subscription and licensing revenues accruing to NZ.
University of Otago	Situated visualisation to enrich sports experience for on-site spectators	3	$1,000,000	Over the last couple of years, we have seen many major advancements in sports broadcasting as well as in the interactivity in sports entertainment. 25 years ago, the first real-time graphics animation of a sporting event was broadcast on television for the Americas Cup, driven by NZ innovation. Nowadays spectators can remotely follow the same event live in real-time using their mobile devices. However, spectators at live sporting events often miss out on this enriched content that is available to remote viewers through broadcast media or online. The main idea of this project is to extend NZ's lead in this field, visualising game statistics in a novel way on the mobile devices of on-site spectators to give them access to information about the sporting event. We will provide spectators with an enriched experience like the one you see in a television broadcast. Our plan is to use new technologies like Augmented Reality to place event statistic such as scoring, penalties, team statistics, additional player information into the field of view of the spectators based on their location within the venue. While currently we focus more on delivering data to the spectators, this approach could be easily extended for supporting coaches and team analysts. Our research will bring sports events closer to the audience, as well as bringing the spectators closer to the events and the teams. We will significantly advance NZ's position in the technological field of Augmented Reality, a field that has recently gained a lot of commercial and public interest and attention. For further information contact: Dr Stefanie Zollmann (stefanie.zollmann@otago.ac.nz).
	Building Better Biocontrols by switching	3	$999,999	In this project we aim to supercharge two biocontrol agents to provide long-term, effective pasture pest control. Two introduced weevils, the Argentine stem weevil and the clover root weevil, attack New Zealand pastures. These weevils are kept in control by two parasitoid wasps. These wasps lay their eggs in the weevils, their larvae eat the wasps, and finally emerge, killing

	reproduction in parasitoid wasps			the weevil. These weevils save up to $550 million per annum in pasture damage, and reduce the amount of pesticides and fertilizer needed to grow pasture in New Zealand. Unfortunately, control by one of these wasps is failing as the weevil out-evolves the wasp that kills it. In this project we aim to supercharge these biocontrol agents through articifical selection. To do this we have to switch the wasps from their current asexual reproduction to sexual reproduction. This switch is possible because it appears that such switches have evolved frequently in these wasps. By switching to sexual reproduction, and seleting for improved efficiency against even resistent weevils, we hope to maintain the biocontrols we have, reducing the need for insecticides, genetically-modified methods of insect control, or the introduction of new biocontrol species. For further information please contact peter.dearden@otago.ac.nz
	Medical device for comprehensive brain monitoring using portable magnetic resonance technology	2	$999,998	Brain tissue is exceptionally vulnerable to ischaemic injury, so early detection and targeted therapy are key to improving survival rates across a wide range of conditions. But current technologies for detecting brain ischaemia are invasive or need costly imaging equipment which is limiting their use. This project aims to develop a non-invasive and cost-effective device that will make it safer, cheaper, and quicker for doctors to diagnose and treat ischaemic brain injuries. We will build on our previous research that showed our concept technology can detect changes in blood oxygenation levels. Our goal now is to design new sensors that can detect a wider range of brain injury biomarkers, such as tissue diffusion and perfusion. This will provide doctors with a full picture of brain injury processes so that treatments can be given in a targeted fashion. The technology will be portable, and provide data in real-time so that treatment decisions can be made accurately with minimum delay. The device will be built in New Zealand and designed in partnership with health professionals who will use the technology. We will work with New Zealand's biotechnology industry to make the device accessible worldwide. This proposal is a key step towards our vision of New Zealand export sales of medical devices that enable comprehensive brain monitoring at the point of care. Since tissue ischaemia is the world's most common brain injury mechanism, such a versatile device can revolutionise the treatment of neurovascular disorders including stroke and traumatic brain injury. For more information

				contact Associate Professor Shieak Tzeng, shieak.tzeng@otago.ac.nz.
	Mātauranga Māori guided discovery and development of new control methods for Phytophthora	2	$1,000,000	Phytophthora are microscopic organisms that cause root rot and dieback diseases in thousands of plant species. It was a Phytophthora species which caused the Irish potato famine in the 1840s. Today they continue to devastate native ecosystems and cause billions of dollars in damage annually. Two species of particular importance in New Zealand are Phytophthora agathidicida, which causes kauri dieback disease, and Phytophthora cinnamomi, which causes root rot in avocados and other agricultural crops. Our Smart Idea is that native New Zealand plants produce unique anti-Phytophthora chemical compounds, to protect themselves from infection. Our goal is to isolate, identify and characterise these compounds, so they can be turned into naturally-inspired products for stopping the spread of kauri dieback and preventing avocado root rot. Mātauranga Māori will be used to identify native plant species with bioactive, anti-pathogen characteristics. Biochemical and microbiological methods will be used to isolate anti-Phytophthora compounds from these native plants, and to test their ability to inhibit various stages of the Phytophthora life cycle. The most promising compounds will also be tested for their effectiveness at stopping infections in controlled glasshouse trials with seedlings. Our team of experts comprises scientists from the University of Otago, Plant and Food Research and Lincoln University, in equal partnership with mana whenua possessing Mātauranga Māori of NZ native plants. Together, we are poised to deliver a uniquely New Zealand solution to the uniquely New Zealand problem of P. agathidicida, which is killing our iconic kauri trees. We will also help to grow the value of the agrichemical and avocado industries. More generally, our cutting-edge science will deliver naturally-inspired, NZ-branded products for fighting Phytophthora around the world. Contact: Dr. Monica Gerth (monica.gerth@otago.ac.nz).
	Targeting unique virus proteins with small	2	$927,440	Viruses affect human and animal health, cause large economic losses, and burden healthcare facilities. For many viruses, there are limited or no treatments. One effective means of controlling viruses is the use of antivirals, small chemical compounds that prevent or block viral infection to

	molecule inhibitors			provide rapid control during disease outbreaks or where there are no vaccine options. This Smart Idea takes a new approach to antiviral discovery by targeting unique proteins found in many viruses. Viruses have limited genetic material. To overcome this limitation, viruses program the production of viral proteins designed to be structurally flexible and take on many different roles. This flexibility is due to defined regions within the viral proteins, making them great antiviral targets. We will identify new compounds that bind these regions of viral proteins. This will pave the way for the development of new antiviral treatments. We will demonstrate Proof-of-Concept with noroviruses. The discovery of new antiviral drugs against norovirus will reduce the health, economic and productivity losses seen during norovirus outbreaks. Critically, this screening paradigm will enhance New Zealand's ability to rapidly respond to new and emerging viral diseases, to develop and market new antiviral agents against viruses, and to be innovators in the pipeline of development of antiviral agents.
University of Waikato	Transforming Motion Error in Time-of-Flight Range Imaging to a High Value Measurement	3	$953,424	Cameras fitted with the emerging time-of-flight technology can measure the distance to an object by measuring how long it takes light emitted by the camera to reach the object and return to the camera. The distance measurement is accurate when objects are still; however, if people and/or objects move, the image is blurred, causing significant errors in the distance calculation. For dynamic scenes, time-of-flight cameras are used only where distance does not have to be measured accurately (for example, gesture control in devices such as TVs). We plan to solve the problem of motion blur and increase the accuracy of distance measurements, which will allow the full potential of time-of-flight cameras to be realised. We will do this by redesigning the hardware and operation of time-of-flight cameras so distance and motion can be accurately measured simultaneously. This means we will convert the problem of motion into an advantage. The key benefit of the new system is a new imaging platform with significantly broader applications and improved data quality. We will produce a new class of algorithms and robust, practical hardware for enhanced time-of-flight imaging. We will collaborate with our established end-users, New Zealand manufacturers of industrial equipment (such as baggage conveyances, on-farm monitoring, food production lines,

				and security cameras), to substantially improve productivity, efficiency and performance of the equipment and explore potential new applications. Expected economic benefits to New Zealand include export earnings from ToF-enhanced equipment sales by our end-users; licensing of our ToF camera system worldwide; enhanced competitive advantage of New Zealand businesses using our ToF technology; new employment opportunities in specialist three-dimensional imaging; and position New Zealand as a world leader in time-of-flight solutions development.
	Biologically based visual sensors for autonomous flight control and mobile robotics	3	$999,759	"This is the droid you are looking for." Currently small robots and unmanned aerial vehicles (UAVs) are limited in their ability to avoid obstacles. This is because existing sensors used for obstacle avoidance, such as lasers, are impractical on small robots. These vehicles are therefore not fully autonomous; they require a human operator for travel or flight through complex environments, which limits their utility and the types of environments in which they can operate. Our research will use knowledge of how the human eye and brain solve the problem of visual navigation to develop an efficient, lightweight, intelligent sensor that enables small robots and UAVs to self-navigate in cluttered environments or locations where GPS is unavailable. Our group is developing a model that simulates the mechanisms used by the primate brain to extract navigation information from the type of visual image motion found in video sequences. Our sensor will rely on the output from a single, small video camera, not the multiple bulky sensors currently used in autonomous vehicles such as the Google self-driving car. The advanced capability provided by our vision model and sensor will increase productivity and efficiency in multiple New Zealand industries such as farming where robotics and UAVs are used and open up new fields for robotic exploration. It will provide the New Zealand robotics industry with a major competitive advantage in rapidly expanding global markets such as UAVs and autonomous vehicles.
	NetStinky: Allowing Regular Users to Detect Compromised	3	$997,182	The goal of this research is to produce systems to support the general public in identifying compromised systems within their home networks. Systems that are compromised typically operate in noticable ways, which allows them to be detected both within the home network, and by other systems in the Internet. Most current industry and research focus is on detecting and

	IoT Devices in Home Networks			remediating compromised systems in enterprise networks. We will build an open-source home router intrusion detection system, a smartphone application, and server system to identify and report evidence of compromise to the home user. Our research will significantly advance the knowledge and tools available to the general public of New Zealand to protect themselves online.

**** Please note: All public statements provided in this document were supplied by applicants.***

Research Programmes

Organisation	Title	Duration (years)	Contract value (excl GST)	Public statement*
AgResearch Limited	Smarter Lives: New opportunities for dairy products across the lifespan	5	$12,500,000	Our brain determines our identity and controls just about everything we do so, whether young or old, its health is essential to our quality of life. Consequently, caregivers are looking for products that will enhance children's brain development, busy adults want ways to improve their productivity and mood during their stressful, modern lifestyles, and ageing consumers are investing in products that help them stay sharper and productive for longer. One way to achieve these desired outcomes is through eating foods that influence brain performance positively. There is mounting evidence to suggest that frequent consumption of dairy products or probiotics may do just that, but exactly how these benefits come about is not known. The key is in the two-way communication between the gut and the brain, known as the 'gut-brain axis'. We will use cutting-edge techniques to understand how dairy ingredients and probiotics can work together to send signals from the gut to optimise brain development and performance (cognition and stress-resilience). We will also develop prototype foods that combine ingredients in a way that conserves their benefits. We will collaborate with international leaders and be supported by a Scientific Expert Panel to ensure our research plans are world-class. The resulting knowledge will be used by the NZ dairy industry to support claims that their high-value products have validated brain performance benefits. This represents an exciting opportunity to leverage NZ's premier position in the global dairy market to increase export sales of premium products that enable Smarter Lives across the lifespan. Contact: nicole.roy@agresearch.co.nz (Programme Leader)

	Accelerated evolution: a step-change in food fermentation	5	$8,600,000	Fermentation is one of the oldest and most economical methods of producing and preserving food. With globalisation and growing consumer desire for authentic and convenient food products, fermented foods offer flavour appeal and cultural connection, and this underlies their expanding popularity in the 'natural' food space. Consumers and government agencies also seek to minimise the use of unwelcome added ingredients such as salt, stabilisers and preservatives. Fermentation can serve as a widely accepted form of processing that can add value, create differentiation and novelty in otherwise narrow ranges of flavours, and facilitate clean-label product formulations containing fewer added ingredients. We will create a step-change in the way that the microbial cultures responsible for fermentation are identified and applied by accelerating their evolution with the aim to improve desirable characteristics such as flavours and textures. This will unleash their innate capacity to deliver valuable fermentation functionality to NZ natural resources such as dairy, meat and seafood, leading to new, premium foods. We aim to predict how people will experience and enjoy new fermented food by mathematically modelling the tastant compounds and textures of model foods, based on molecular profiling and responses of human taste receptors in cell culture, against the evolved biology and metabolism of microbial strains. This will then be correlated with sensory evaluation to identify NZ unique flavour signatures in exemplar food products. This research builds a new generation of science and technology outputs to support the growth of NZ food manufacturing industry across multiple food sectors (dairy, meat and seafood) in the niche high value fermented food category. Implementation of this research will contribute to the NZ Business Growth Agenda to increase exports and grow more connected businesses.
Cawthron Institute	Emerging organic contaminants – managing risk for a safer NZ environment and economy	5	$5,607,675	Emerging organic contaminants (EOCs) are natural or manufactured chemicals found mostly in consumer products. They are used daily and can be released into the environment in significant quantities. Research in Europe and North America shows a

				correlation between EOCs found in the environment and human settlement. They are seldom regulated as their effects are normally associated with long-term effects of exposure rather than immediate acute effects. Regulators, the food industry, Māori and the wider community are increasingly concerned about the risk EOCs pose to human and ecosystem health. Preliminary research in NZ suggests the concentration of EOCs in wastes and receiving environments is similar to that reported in other developed countries. We have limited knowledge of the impacts they pose to water quality, our unique aquatic ecosystems, the development of antimicrobial resistance, or our economically significant primary industries. Our interdisciplinary team of local and international scientists will identify those EOCs predominating in NZ aquatic ecosystems, characterise their risk to our unique taonga, their potential to induce antimicrobial resistance, and investigate their presence in food. In partnership with iwi, key community stakeholders and environmental managers and policy makers we will identify solutions that enhance regional and national management of EOCs in NZ. Our novel research will be applied to develop a framework to sustainably manage EOCs by protecting NZ aquatic ecosystems, thereby safeguarding New Zealanders from their harmful impacts, and ensuring NZ food and beverage export products continue to meet all necessary trade requirements.
	Optimising detection, diagnostic, prediction and management strategies for NZ aquaculture health	5	$14,598,200	This research addresses the risk to NZ aquaculture from infectious diseases and aquatic health issues. There is an urgent need to protect existing production, ensure security of market access and meet government and industry aspirations for aquaculture growth and diversification. This programme will develop essential capacity, capability and decision-support systems required not only to future-proof the growth and diversification of NZ aquaculture, but also to position us among the international decision makers to ensure that procedures and ordinances are relevant and suitable for New Zealand. The proposed research will enable us to move away from existing health

				monitoring and diagnostic approaches, which frequently result in inconclusive results and fail to address emerging issues until substantial losses have occurred. An international team, with close end-user links, will enable industry-relevant cutting-edge research, leading to optimal diagnosis, prediction and management of disease issues. Diagnosis encompasses health assessment and pathogen detection. It involves developing and optimising cost-effective procedures integrating traditional methods with cutting-edge technology-based approaches. Prediction will integrate diagnostic methods to characterise 'normal' health and the causal linkages between host, pathogen and environment in the progression to poor health or degraded product quality. Epidemiological investigations, combined with novel risk-assessment approaches, will elucidate the implications of disease for multi-species aquaculture regions and the wider environment. Management draws on diagnosis and prediction to develop an integrated management system for marine farmers, including early warning surveillance tools, and proactive options for dealing promptly with health and disease issues. High-risk disease 'pathways' will be identified and managed, and methods for on-farm mitigation developed. Risk-based decision-support tools will enable informed management decisions based on accurate diagnoses, costings, and benefits.
Institute of Geological & Nuclear Sciences Limited - Trading as GNS Science	Our lakes' health: past, present, future - Me hoki whakamuri kia haere whakamua	5	$11,999,265	The health of many of our lakes is deteriorating, yet our ability to make informed assessments at a national scale is hampered by a paucity of critical knowledge. Of the 3,821 lakes (>1 ha) in New Zealand, we have knowledge on lake health for fewer than 5%. A simple fix might be to initiate more monitoring programmes. However, this would be costly and would not necessarily tell us how or why deterioration has occurred, nor what might be done about it. The solution can be found in the lakes sediments. Laid down year upon year, sediments preserve indicators of lake life and water quality, equivalent to centuries of monitoring. These natural archives can provide the deeper understanding we seek to properly restore the ecological vitality of our lakes.

				This project will characterise the health of our lakes by uncovering their environmental history using the latest techniques such as eDNA and high resolution scanning. Our data will allow us to characterise current lake health and explore rates and drivers of change over the last 1000 years. Working with iwi and hapu, we will learn from their Mātauranga and oral histories that draw upon long associations of tangata whenua interactions with lakes, to enrich and inform our joint aspirations for environmental reconstructions. The data from this project will be used by government agencies to undertake strategic assessments of water quality and health risk, prioritise mitigation strategies, characterise biodiversity, assess the distribution and impact of invasive species, and to inform environmental policy. Regional councils, iwi/hapu and other communities will use this new knowledge to assist in setting informed and achievable restoration aspirations.
	Economic opportunities and environmental implications of energy extraction from gas hydrates	5	$7,663,790	Gas hydrates are ice-like substances of natural gas that exist beneath large areas of New Zealand's seafloor. Storing large amounts of methane, they represent an attractive energy resource. In recent years, the New Zealand Government has invited commercial bids from the petroleum industry to explore for gas hydrates. At the same time, active commercial exploration of conventional oil and gas has moved into deeper waters where future production will require drilling through gas hydrates. Any future commercial discoveries would result in significant government revenue for public-good spending on community infrastructure and services. On the other hand, because gas hydrates are an important part of the natural marine environment, these recent developments highlight a need for (1) an assessment of the potential environmental impacts of producing natural gas from (or beneath) gas hydrates, and (2) a better understanding of the role that gas hydrates could play in New Zealand's future energy demand. There is also a need to understand socioeconomic implications of developing this new energy resource. By undertaking marine, economic and social science research, our team will investigate

				the balance between economic opportunities, cultural values and environmental risks associated with extracting gas hydrates. Even if New Zealand adopts the most ambitious targets for greenhouse gas emissions, natural gas will be required as an energy resource for many years to come. As such, we aim to describe frameworks under which gas hydrates could be produced economically, as well as socially and environmentally responsibly. Our social engagement strategy will encourage informed discussion between scientists, government, industry and the public about the role of gas hydrates in New Zealand's future energy landscape and our responsibilities for the natural environment, both locally and globally.
	Increased Utilisation of Geothermal Energy Through New Integrated Geoscience Methods	5	$6,250,000	New Zealand has taken on the challenge to increase electricity generation from renewable sources. Of the common renewable energy sources in New Zealand, geothermal has a unique advantage of being unaffected by climatic conditions in contrast to hydro, wind, solar and wave power. To meet the goal of increased generation from secure renewable energy sources, geothermal energy needs to be at the forefront, requiring new geothermal developments, and expansions and optimisations of existing plants. Geothermal developments have high upfront costs, which are compounded by the uncertainties of accessing underground resources. For example, productivity of wells can only be determined after drilling. Developers in New Zealand are seeking new approaches to estimate and mitigate the risks associated with new or expanded geothermal developments. Key unknown information are the properties of the rocks and fluids many kilometres below ground needed to make reliable predictions. Obtaining this knowledge and making predictions are challenging research tasks that have applications in the geothermal sector in New Zealand and throughout the world, and spill-over benefits to other activities using underground fluids. In this research programme we will develop new approaches to interpret and extract information from data measured in geothermal fields. This work will build on research undertaken at GNS Science and the University of Auckland over the last 20 years. The

				major focus in the programme is developing new approaches to couple data and methods from different geoscience and engineering disciplines. The result will be significantly improved capabilities to assess sustainable development sizes for new geothermal systems; improved predictive models that will help optimise existing geothermal developments; and a new framework for communities to assess kaitiakitanga and sustainability.
	Earthquake-induced landslides and landscape dynamics: planning for, and avoiding landslide hazard and risk	5	$8,192,115	Past earthquakes in New Zealand have generated landslides and other sediment hazards that have killed hundreds of people and cost the country billions of dollars. Although the area affected by landslides triggered by the 14 November 2016, MW 7.8 Kaikoura Earthquake is relatively remote with few residents, landslides did cause the closure of SH1 and the North Line of the South Island's main trunk rail line. This prevented people and goods from entering or leaving the town of Kaikoura. Four months later, the highway north of Kaikoura was still closed. Evidence from previous earthquakes in New Zealand and overseas suggests that the frequency of landsliding after a large earthquake is significantly higher than before the event. This is because strong earthquakes cause slope cracking and generate a lot of landslide debris. The debris generated by the Kaikoura Earthquake, when mobilised, will create new hazards, including further landslides, landslide dams and dam failures, rapid aggradation, and increased river channel instability, as the debris cascades from hillslope to sea. These hazards may persist for decades and therefore represent a prolonged risk that must be considered by the impacted communities and stakeholders. We will develop a suit of predictive tools, guided by an evidence-based decision making framework, which will allow the risks to people and infrastructure from landslide and sediment hazards generated by earthquakes and post-earthquake rain and aftershocks to be effectively managed. We will improve New Zealand's understanding of these old and new hazards by studying the catchments impacted by the Kaikoura Earthquake and use this knowledge to inform our understanding of how Kaikoura and other regions of New Zealand may be affected by earthquake-induced and post-earthquake slope

				hazards.
Landcare Research New Zealand	Advanced remote sensing of Aotearoa for next generation land cover mapping	5	$7,750,000	Accurate, up-to-date mapping of land cover and land use is a critical environmental information gap in New Zealand. Land cover information is widely used by government to report on environmental performance and by landowners, including Māori, to make resource management decisions and identify economic opportunities and risks. However, current land cover maps in New Zealand are costly and do not meet user needs. The research will develop new methods to unlock next-generation satellite-based remote sensing; analyse vegetation phenology and structure; and synthesise vegetation plot data. We hypothesise this world-first, triple-combination approach will enable an up to ten-fold increase in the thematic accuracy of vegetation mapping. This step-change in land cover mapping will improve environmental policy, regulation, and reporting by the Natural Resources Sector, and boost economic productivity by primary sector and Māori landowner interests. This research will deliver important benefits, including improved: • characterisation of environmental condition for national and international reporting • evidence to support limit-setting under the Freshwater Reforms • biodiversity monitoring and more targeted conservation and pest control efforts • determination of the quantity/timing of flowers to optimise manuka honey harvesting • characterisation of habitats (e.g. wetlands) to prioritise protection/rehabilitation, and identify regional economic opportunities • forest mapping to manage kauri dieback and protect kauri, a taonga species • vegetation mapping to improve fire management

				Wider benefits from the research include: • improved community capacity to engage with land mapping, lifting Māori and regional development • greater value from Crown investment (e.g. Māori Land Service) • accessible online information which meets open-data and Geospatial Strategy goals • next-generation research/datasets supporting other research
Lincoln Agritech Limited	Bacterial-fungal hybrid endophytes for nitrogen-fixation and stress tolerance in pine and ryegrass	5	$7,213,045	This programme will deliver significant benefits to New Zealand's forestry and pastoral farming industries, through enhancing the availability of nitrogen to, and increasing the stress tolerance of, plants. These benefits will be conferred through new symbioses between the crop plants and plant growth-promoting fungi and bacteria. In other words, the plants, fungi and bacteria are dependent on each other and assist one another. We will select bacteria that fix nitrogen and deliver proteins and polymers that enhance plant tolerance to stress. We will investigate how to successfully introduce these bacteria into two fungi that have the ability to live within plants ('fungal endophytes') - Trichoderma and Epichloë. We will then introduce the fungal-bacterial hybrids to pine trees and perennial ryegrass and test whether the plant-fungi-bacterial combination is advantageous for forestry and pasture growth. Our research is world leading as no other researchers have attempted a triple symbiosis between these fungi, bacteria and plants. Our team from Lincoln Agritech, Lincoln University, Scion and AgResearch includes world-leading scientists who have been instrumental in developing the current industry in fungal biocontrol endophytes, which is already assisting New Zealand forestry and farming through greater productivity and resistance to disease. We will work with companies, Agrimm and Grasslanz, who are already producing/licensing fungal endophytes nationally and internationally. The new fungal-bacterial hybrids will be added to their product lines. Contact: richard.weld@lincolnagritech.co.nz

Lincoln University	Unlocking Export Prosperity from the Agri-food Values of Aotearoa New Zealand	5	$4,000,000	The economic prosperity of New Zealand has long been underpinned by its ability to produce quality agri-food exports from its natural resources. The country's science investment in the primary sector has concentrated on increasing physical production, but the Investment Plan 2016-2019 aims to shift funding towards "supporting knowledge-intensive, high value add and export growth areas". This programme is based on the concept that knowledge-intensive business services can increase the value added to New Zealand's agri-food exports. The research is designed to test the hypothesis that New Zealand agri-food production systems across the primary sector can deliver combinations of physical, credence and cultural attributes that are highly valued by consumers in major global markets. The research also answers questions about exactly what attributes are most highly valued in different markets and which can produce the highest returns to New Zealand producers. The research brings together Professor Caroline Saunders, Dr Roger Harker and Dr John Reid who are experts in these three attributes. Professor Saunders leads a research team at the Agribusiness and Economics Research Unit (Lincoln University). Dr Harker leads a team at Plant & Food Research. Dr Reid is associated with the Ngai Tahu Research Centre. The research will be guided by a partnership with the Te Hono Movement and by an Advisory Board of private sector and public sector industry leaders. Final results will be published progressively through the AERU's Maximising Export Returns Data Portal (accessible at the dedicated website www.lincoln.ac.nz/aeru/mer), with all reports and data available by 30 September 2022. The Science Leader, Professor Caroline Saunders, can be contacted at Caroline.Saunders@lincoln.ac.nz.
Massey University	He Tātai Whenua: A Te Ao Māori landscape classification	4	$2,870,000	Tatai whetu ki te rangi, tatai whakapapa ki te whenua. As there is a myriad of stars in the Heavens so too is there a myriad of layers on Earth.

				Over many centuries Māori have observed every aspect of the world around them. Observation led to an accumulation of knowledge that was in turn passed from one generation to the next via a number of linguistic devices. Māori have a 1000 year history of occupation and therefore a unique and longstanding relationship with the environment and its sustainability. Mātauranga Māori, or Māori expert knowledge in relation to Papatuanuku (our earthly environment) and in relation to kaitiakitanga (stewardship of the environment), offers a potentially powerful pathway leading to revitalisation and reconnection for all New Zealanders to our whenua at a time when global ecological concerns are increasingly relevant. There is a critical need to document this cultural knowledge in order to secure current and future environmental benefit and sustainability. It is also critical to do so in a way that that will enable integration into existing environment databases to ensure maximum usefulness. This will be achieved through broad multidisciplinary science and Kaupapa Māori methodology with hapu/iwi research partnerships. This unique research proposes to bridge not only the science and social science traditions but also the proposes to overlay Western science with indigenous knowledge. We propose to synthesise a Te Ao Māori landscape classification that can be directly integrated into existing Geographical Information Systems. This will be piloted in the Manawatu Catchment. We will produce an international standard for the translation of indigenous cultural and historical knowledge into data structures that can be directly integrated with state of the art landscape datasets.
	Maximising workforce participation for older New Zealanders: Opportunities, Challenges and Prospects	5	$3,996,875	A growing proportion of people in New Zealand aged over 55 are unemployed or underemployed, although many, including those over 65 wish to keep working. Maximising workforce participation by older workers will reduce social expenditure, benefit businesses through retention of skilled workers, and provide improved health and wellbeing to many older people. This research asks: How can government,

				employers, and workers support older New Zealanders' ongoing participation in the workforce? Our research to answer this question includes five specific research aims. The first four will use a longitudinal population study, in-depth interviews, kaupapa Māori methods, and case studies, to examine the needs and experiences of workers, employers, and entrepreneurs. The fifth research aim will integrate the new knowledge and transfer it directly to policy makers, employers, and older workers using consultation and contemporary communication and educational strategies. Using these methods, the answers to our research question will be transformed into information for policy makers, and tools and resources for workers and employers that will help older workers enter and remain in the workforce. The tools and resources will be developed and disseminated in conjunction with business advisors, and our Māori Advisory Group. The methods will contribute innovative, practical, and sustainable strategies to extend working lives, and enable unemployed or underemployed older New Zealanders (55+) to contribute to the workforce if they wish to. This research addresses the societal challenge of an ageing population. A comprehensive investigation of the needs of older workers and employers, and the development of innovative resources will support the full participation of older people. This will benefit all New Zealanders and make measurable contributions to the economy. Please contact Professor Fiona Alpass (f.m.alpass@massey.ac.nz) for more information.
National Institute of Water and Atmospheric Research Ltd	Ross Sea Research And Monitoring Programme: is the world's largest MPA effective?	5	$11,134,920	The world's largest Marine Protected Area (MPA) will take effect in the Ross Sea (Antarctica) in December 2017. Some 1.55 million square-km (600,000 square-miles) of the Southern Ocean will gain protection from commercial fishing for 35 years. The protection of one of the Earth's most pristine marine ecosystems followed a joint New Zealand-US proposal to CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) who manage Antarctic fisheries.

				The MPA comes with requirements to evaluate its effectiveness in conserving ecological structure and function, protecting key species, mitigating threats, and improving our understanding of how marine ecosystems respond to fishing and climate change. These requirements present significant scientific challenges but also provides an unprecedented opportunity to study how large, open-ocean ecosystems respond to fishing and climate change. Our research will also examine the extent to which closing areas to fishing can enhance the sustainability of fisheries and reduce their environmental impact. We will design and implement methods to track long-term change in the Ross Sea ecosystem, and develop approaches for disentangling the effects of human exploitation from natural variability and change. With our iwi partners, we will explore Māori values and aspirations for future management of the Ross Sea region. Working out what, where and how to measure change is challenging; the Ross Sea region is vast, remote and inhospitable. We initially intend to focus on animals and areas known to be particularly important to the food-web, including phytoplankton at the base of the food-web, crustaceans that graze the algae (including krill) and small free-swimming fish. At the top end of the food-web, we will study Antarctic toothfish, as well as Adélie and emperor penguins and Weddell seals.
New Zealand Winegrowers	Growing returns through dissociating quality from productivity in NZ Pinot noir production	5	$9,313,300	This programme will help the NZ wine industry success story continue into the future. We will grow production of Pinot noir wines, satisfying significant international demand from countries including the US, Australia and China for these cool climate red wines. Increased Pinot noir production will diversify the products and locations from the wine industry, which is currently dominated by Sauvignon blanc. Driving export growth in Pinot noir requires consistent production of high quality wine at a price point acceptable to the customer. However there is an apparently inextricable seesaw link between productivity and quality; industry needs methods to produce 10 tonnes /hectare of grapes while maintaining the quality standards only achieved at 6 tonnes/hectare productivity.

				Our research will identify how industry can break the productivity-quality link through four areas of interconnected research. We will identify what 'quality' means to wine consumers and how that 'quality' is related to the wide variety of chemicals that make up Pinot noir wine. We will identify the fundamental biological and chemical controls of the critical components of Pinot noir, and trial manipulating them in the vineyard and the winery to produce consistently high quality wine at high productivity. Researchers and industry will work closely together, trialing laboratory findings in the field. The end result will be major expansion of the areas growing Pinot noir grapes and export returns to New Zealand. Contact: Dr Simon Hooker simon@nzwine.com
The New Zealand Institute for Plant and Food Research Limited	Filling the void: boosting the nutritional content of NZ fruit	5	$5,150,000	The skin makes up less than 10 per cent of a fruit. Yet it contains nearly all the compounds that provide a nutritional benefit. These benefits are largely derived from biologically active secondary metabolites (phytochemicals). Popular examples of fruits that exemplify this include apples, pears, and blueberries. If we could direct synthesis of these compounds into the flesh as well as the skin, the nutritional value of the fruit would be greatly enhanced. Our research will discover how to increase phytochemical production in fruit flesh. Our exemplar will be blueberry. The 'superfood' status of blueberry belies the fact that the white flesh of the fruit is largely devoid of the beneficial phytochemicals. As a test case, we will direct production of the phytochemical anthocyanin, which provides the skin colour, into the flesh. The intent is to improve both the nutritional value of NZ blueberries and their visual appeal, providing differentiation for prospective consumers and a new product category. Combining our world-leading plant phytochemical knowledge with a new high-value crop will provide a number of new opportunities, leading to both economic and societal benefits. The team, consisting of researchers from NZ (PFR and University of Auckland), USA (USDA and North Carolina State University), Italy (FEM, Trento), Norway (The Arctic

				University of Norway) and Finland (University of Oulu) will work with fruit breeders and our industry partner to initiate breeding strategies for new fruit crops. The knowledge gained from blueberry can then be used to improve other NZ fruit crops such as apple, pear and kiwifruit. This will advance our ability to deliver new, high quality fruit locally and into export markets, particularly niche premium price segments. Contact: Richard.espley@plantandfood.co.nz
The Research Trust of Victoria University of Wellington	Improved sea-level rise projections for New Zealand to better anticipate and manage impacts	5	$7,107,435	A recent report by our Parliamentary Commissioner for the Environment states: "It is certain that the sea is rising and will continue to do so for centuries to come. But much is uncertain – how rapidly it will rise, how different coastal areas will be affected, and how we should prepare." Clearly there is a need to know how future sea level rise (SLR) will affect New Zealand and New Zealanders, yet detailed knowledge of likely sea level change along our coastline and the environmental impacts of this change is limited. To address this need, the NZ SeaRise Programme will produce accurate estimates of the magnitude and rate of sea level rise for our coastal regions to 2100 and beyond. We will use these new projections to examine environmental impacts and risks associated with increased coastal flooding due to storm surge and rising groundwater levels and incursion of salt water into coastal aquifers, estuaries, and wetlands. Our programme will improve global- and regional-scale sea level projections, which currently underestimate the amount of future SLR because they do not include accurate estimates of the contribution from melt of ice sheets in Antarctica and Greenland. We will then establish local sea-level projections that include the effect of land movement. This is important as ground subsidence may cause local sea-level to rise by 20 to 30 cm by the end of the century. Finally, we will assess the environmental impact of the new SLR projections in Wellington, Dunedin, Auckland, and the Hawkes Bay. These impact studies will be designed with stakeholders. Outcomes will include improved decision making, risk management, and adaptation planning based on locally relevant SLR scenarios and vulnerability assessments.

	ECLIPSE – Eruption or Catastrophe: Learning to Implement Preparedness for future Supervolcano Eruptions	5	$8,246,225	New Zealand's central North Island hosts a huge supervolcano system, the most active of its kind on Earth. This system becomes restive every few decades and erupts every few hundred years on average, sometimes in tiny events, and sometimes devastating much of the country. This system will reactivate in the future, to unrest or eruption, yet our understanding of what occurs in these events does not allow us to respond appropriately and there is the possibility of major panic. Our research aims to reduce the uncertainty around future unrest or eruption. We will study what makes this supervolcano system become restive or move into eruption, and consider the hazards and impacts of likely future eruptions in order to reduce the risk of an inappropriate response. We will investigate the underground roots of the volcanic system through what it has erupted (pumice and ash) to identify what conditions cause it to become restless or erupt. We will see if we can identify a tipping point at which unrest becomes eruption, then build our knowledge into advice for monitoring the volcanic system in partnership with the GeoNet programme. We will place future eruptions into modern society to understand and mitigate against the impacts of any future events, and we will design strategies to reduce uncertainties about future unrest or eruptions. The programme will create world-class scientific knowledge that will inform and enable Iwi and Civil Defence to deal with the likelihood and impact of future events, whether unrest or eruption. Our work is linked with a parallel European volcanology programme to build an understanding of similar volcanic systems worldwide, drawing on a wealth of international experience. For extra information contact: colin.wilson@vuw.ac.nz.
	Tissue repair technologies based on novel sulfated sugars	5	$6,203,540	This five-year research programme led by the Ferrier Research Institute at Victoria University of Wellington is focused on preparing novel products that facilitate tissue repair. The technology being developed will replace the existing treatments that have undesirable side effects, nominal efficacy, significant cost, and low biological stability. Heparan sulfate is a natural polymer present in the extracellular matrix throughout the

				human body and variants are produced by every cell-type. At sites of injury, the body produces growth factors to mediate the repair process. Heparan sulfate is an essential "match-maker", connecting growth factors to their cognate cell surface receptors. The application of specific components of natural heparan sulfate has been shown to accelerate injury repair, but natural heparan sulfate is in particularly limited supply. Our team has developed a method to overcome the supply issue with a material that is more biologically active than the natural product. The research programme will use this break-through technology to produce highly-active implants, prepared by chemical synthesis from readily available starting materials, providing new opportunities for high value manufacturing in New Zealand. This research builds on intellectual property developed at the Ferrier Research Institute (Victoria University of Wellington) and leverages several New Zealand Industries for supply and manufacturing expertise. Collaborations with the University of Otago, University of Liverpool (UK), Agency for Science, Technology and Research (Singapore) complete the research platform. Commercialization activities are being provided via SMC-Bio (US), KiwiNet, Vic-link and Powerhouse-Ventures. For further information please contact: Rachel Odlin, Institute Manager, Ferrier Research Institute, Victoria University of Wellington, 69 Gracefield Road, Lower Hutt, (04) 463 0057.
	Ultra-high speed superconducting machines for hybrid-electric aircraft	5	$6,299,995	New Zealand's economy depends on aviation. Whether we are exporting high-value products to the world, or welcoming tourists to our shores, we rely on airlines to serve us. But the age of cheap flying is behind us. When the world met in Paris in 2015 to address the challenge of climate change, 195 nations agreed to restrict the global temperature rise to 1.5 deg by cutting their greenhouse gas emissions. The Paris Accord has now come into effect, and there is a global effort to replace fossil fuels for transport. Aviation is the most climate-intensive

				form of transport. It is responsible for 5% of global warming. Worse, aviation emissions have grown by 75% since 1990, double the rate of other sectors of the economy. Countries are now looking how best to reduce their aviation emissions. Serious options include a climate tax on air tickets, and investing in new, clean technology. New Zealand has committed to reducing its GHG emissions. But our economy would suffer if a climate tax meant that tourists couldn't afford to fly here. International tourism brought $12 Bn into the economy last year. We rely on it. New Zealand has an important role to play in developing clean aviation technologies, such as hybrid electric aircraft. This research programme is part of our 30-year programme of leading high-temperature superconducting work. The New Zealand team will work on key aspects of the high-torque, high-speed machines needed to make electric aviation a reality. Their international partners include Lockheed, Boeing, and NASA. There are opportunities for NZ companies to produce specialised, high-value components for the hybrid electric supply chain, earn export revenue, and contribute to solving this pressing global problem.
University of Auckland	Development of robust IPT pavement systems for electric vehicles	5	$11,825,955	It is now agreed that the world must halve its emission of greenhouse gases by 2050. New Zealand's per capita emissions are about three times the world average. By reducing our reliance on burning fossil fuels, we can achieve the necessary cuts without impacting primary production. Making the switch to electric vehicles (EVs) is an essential part of meeting our international commitments - and it's government policy. But even though over 80% of our electricity is generated from renewable sources (hydroelectricity, geothermal, wind, and solar), there are still barriers to be overcome. First of all, electric cars need to be recharged more frequently - their range is much less than for petrol vehicles. More public charging points are needed - but charging takes time. Also, grid operators worry about meeting peak demand when everyone arrives home and plugs their car in. The solution to these problems is to develop technology that enables EVs to be charged

				as they are parked or moving along the road. It's a challenging goal, since it requires us to develop new charging pads that can survive being put into the roadway and create new charging materials made of soft composites. We will need to modify the construction of the roadway itself so the charging system will perform well over years. Our partners from the electricity and transportation industry, the Ministry of Transport, NZTA, and Auckland Transport are keen to help. This proposal is timely. The wireless charging technology was developed by NZ researchers and has already proven itself. We now have an opportunity to export our novel roadway charging technology to the world. Our dynamic charging roadways will enable a safer, cleaner world for everyone.
	Smart sensing of physiology to grow the NZ Medtech industry	5	$11,981,875	This programme will develop a novel, multi-purpose pressure sensor for giving insight into the status of diseases such as heart failure and urinary function. Pressure is a very important parameter, but it is hard to measure pressure inside the body. The biggest issue is that, when pressure sensors are implanted, their readings gradually drift over time i.e. the pressure they report is incorrect. We have developed the concept for a novel solution to this drift in readings, which we will prove in this programme. We will then combine our novel pressure sensors to create an entire technology which is self-powered and reports data from inside the body to the outside, based on our team's capability in wireless power technology and cloud computing. We will test our sensor technology through two specific applications, which have strong clinical evidence of unmet need – a pelvic floor training tool to reduce urinary incontinence and an implantable device for monitoring brain pressure in people with hydrocephalus (where spinal fluid accumulates inside the skull and puts pressure on the brain). We will prove these devices to the point where they will be spun out into new companies to be commercialised. The medium term impact of our programme will be a ripple effect to create an ecosystem of supporting companies earning new export revenue, in diverse areas of electronic manufacturing, 3D printing, clean room

				technology, telecommunication networks, cloud based healthcare applications, electronic health records and regulatory support. A spill-over benefit from the Programme will be better health outcomes for the NZ population and reduction in NZ health costs.
	Fast, Efficient and Tailored Pulsed Laser Micromachining and Additive Manufacturing	5	$11,802,990	Ultrafast laser processing of materials exploits the ability of brief pulses of light – pulses much shorter than a billionth of a second long – to sculpt materials with amazing precision to create designs and structures that cannot be manufactured in any other way. It is also one of the fastest growing sectors in the already very dominant laser manufacturing industry, with growth of 20% or more per year. This ambitious research project, led by the Photon Factory and physics laser labs at the University of Auckland, will advance the state-of-the-art in ultrashort laser – matter interactions that underpin these extraordinary processes. Our long-term vision is to have transformative impact on laser manufacturing in three ways. We will provide powerful new laser micromachining and 3D printing capabilities to the photonics industry. We will demonstrate the power of those advances through showcase projects with industry partners – many of which are not in the photonics sector. Gas sensing, sperm sorting for agriculture, “point of cow” milk analysis on the farm, high tech electromagnets – these are some of the wide ranging advances this technology enables. Finally, we anticipate much broader impact – to foster a widespread creative innovation culture in NZ by providing techniques and expertise to help drive tomorrow’s distributed manufacturing economy, through the laser cutters and 3D printers in our small companies, large industries and home workshops.
University of Canterbury	Community concerns, key species and wahi taonga – recovery trajectories of the marine ecosystem from the Kaikōura earthquakes	4	$3,184,344	The 7.8 M Kaikoura earthquake brought unprecedented changes to the coastal ecosystem along 130km of New Zealand’s South Island. Uplifting of the nearshore zone by up to 6m propelled formerly subtidal rocky reefs out of the water, with extensive mortality of taonga species, such as paua, and the critical kelp bed habitats that support the nearshore ecosystem. Erosion of newly exposed sedimentary rocks deposited fine silt over rocky reefs extending far out to sea, smothering many bottom-dwelling species.

				Commercial, cultural and recreational uses of the marine environment were greatly affected. This research aims to understand the consequences of this massive 'tipping point' in our coastal ecosystem: What will be the trajectories of change and recovery? How can resilience be aided by potentially 'safe havens' provided by Customary Protection Areas such as rahui, taiapure and mataitai areas that may provide sources of reproduction of key species? We will build on a 25-year data set of sampling and experiments around this coastline, and test the degree to which small-scale experiments tell us about recovery processes over such a large area, which affected population connectivity, critical relationships between species necessary for recovery, and important interactions affecting recruitment dynamics of key species. We expect recovery to take many years and that new configurations along the rocky coast will generate new uses but also potentially added impacts. The Kaikoura earthquake has provided a historically unique opportunity to gauge such large effects and understand ecosystem responses. The programme involves a wide range of skills, with Mātauranga Māori as a focus. The results will feed into management strategies and public awareness, as well as having great international interest to the scientific community.
University of Canterbury	Map-based tools for Community and Rūnanga-led sustainable town planning in small and medium settlements in New Zealand	3	$2,570,250	Current urban and town planning processes in New Zealand present few ways to include local knowledge and bicultural views in the decisions affecting cities and towns. This project looks at developing new ways and tools to improve collaborative planning in New Zealand, by including local knowledge from communities and Runanga in town planning. These tools can be developed as maps, mobile applications, or websites, to provide local communities with opportunities to have a say about local needs, priorities, and concerns. The project focuses on two cases, the Waimakariri and Rotorua, in which the tools can be developed in relation to their specific contexts, and then can be replicated in other towns and cities across New Zealand facing similar town planning challenges. Many towns in New Zealand are exposed to natural hazards, and how

				communities and governments plan for post-disaster recovery coupled with population growth in the Waimakariri can provide relevant lessons across the country. The case of Rotorua is equally pertinent, providing insights to other towns in New Zealand, also growing rapidly in population, resulting in urban development pressures and fast-paced transformation affecting the lives of resident communities. For this, the research will identify how best to connect and communicate with Runanga and other local communities, to collaboratively define what the tools should look like, and how they should be created with, and for, communities. Once developed, these tools will provide communities with a platform to share and exchange information and knowledge about issues impacting their towns, informing and connecting to planning processes. For more information about this research project, please contact Dr. Rita Dionisio (Dep. Geography, University of Canterbury) at rita.dionisio@canterbury.ac.nz.
University of Otago	Developing and applying next generation genomic selection to rapidly improve honeybee performance	5	$6,344,620	Honeybees are critical to New Zealand's rapidly expanding and high value export seed and honey industries, and underpin the production efficiencies of horticultural and forage-based sectors. To achieve the government's Business Growth Agenda's export targets, these sectors require a step-wise change in their productive capacity. This programme will develop and deploy a honeybee selective breeding system, using modern genomic and bioinformatic tools and quantitative genetics methods, that will effectively and rapidly improve New Zealand's Bee stock.
	Real-time analytical molecular diagnostic laboratory in the palm of one's hand	4	$5,999,792	Despite advances in diagnostic technologies, the ability to rapidly and accurately diagnose infectious disease lags behind what the world requires. Diagnostic tools able to deliver immediate actionable information (i.e. at the point-of-care or in-field) would address the health and environmental challenges we are facing globally. Some challenge examples include water contamination in Havelock North, HPV testing to provide cervical screening in hard to reach populations, containment of new and emerging diseases like Ebola and SARS, and prevention of antibiotic resistance. Solutions must be simple, accessible, accurate and yield rapid results, thus, facilitating appropriate and timely community response and cost-effective treatments to optimise health outcomes.

				We will develop a 'sample-to-result' molecular diagnostics platform designed for simplicity that allows non-experts to deliver results rapidly at the point-of-care, enabling frontline professionals to take immediate action. We will do this by incorporating our patented chemistries with a new hardware solution to make a single diagnostic device. This device will purify samples, detect the diagnostic marker and report the result to the operator in under 15 minutes. The user interface will guide the operator through device set up, intelligent algorithms will automate data interpretation and results will be presented unambiguously. Our technology targets a global market. We are uniquely poised to dominate point-of-care diagnostics markets (US$19.3billion p.a.) with solid in-roads into laboratory and in-field testing markets. Benefits to NZ include establishing a significant export industry in high-value products, R&D stimulation in the biotechnology sector, quality job creation and new growth opportunities. This proposal leverages previous NZ investment that delivered patented technologies providing freedom-to-operate. Our research places NZ at the forefront of the molecular diagnostics world stage. For more information contact: jo.stanton@otago.ac.nz

**** Please note: All public statements provided in this document were supplied by applicants.***

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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